

The Identification of Two Species of *Junonia* Hübner (Lepidoptera: Nymphalidae): *J. evarete* and *J. genoveva* in Jamaica

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Abstract. The validity of the two species *Junonia evarete* and *Junonia genoveva* originally described by Cramer from Surinam is re-established and recognized in Jamaica. The relevant literature of this group is reviewed and the synonymy of these species is discussed. Morphological, behavioral and chromosomal differences between the adults of the two species are discussed and notes on the life histories and immature stages are included.

Introduction

Since Hübner (1819) described the genera *Precis* and *Junonia*, much controversy has occurred as to whether the type species that were later designated for the two genera were congeneric. Whether the use of *Precis* or *Junonia* should be adopted is not within the scope of this paper, but we have agreed with Comstock's (1944) argument here to retain the name *Junonia* for the Jamaican buckeyes.

The first major revision of the group was published by Forbes (1928) who used the name *lavinia* (Cramer, 1775) for all Central American, American, Caribbean and South American races of *Junonia*. Comstock (1942) subsequently pointed out the invalidity of the name *lavinia* and proposed the next available name *evarete* (Cramer, 1779). As the types of *lavinia* and *evarete* both were described from Surinam, they were thought to be conspecific, and Comstock (1944) used the new specific name *evarete* and recognized three Puerto Rican subspecies, *J. e. coenia* (Hübner), *J. e. zonalis* (C. and R. Felder) and *J. e. genoveva* (Cramer).

Bates (1935) had previously treated *Junonia* (= *Precis*) *coenia* and *J.* (= *Precis*) *zonalis* as distinct species in Cuba. Munroe (1949) retained subspecific rank for *J. e. coenia* and *J. e. zonalis* and stated, "in Cuba, the equivalent of a species difference exists between the two forms *coenia* and *zonalis* which are almost identical in genitalia". Munroe (1951)

separated *J. coenia* as a distinct species from three forms of *J. evarete*, namely *zonalis*, *michaelesi*, and *evarete*. He designated these three *evarete* forms as "wet and dry" phenotypes comparable to phenological variants seen in related Old World forms. He, however, reported that on some West Indian islands, both forms occur together in the same season, and on other islands, one or other form appears to be absent. Torre y Callejas (1971, 1974) retained the specific rank of *J. coenia* but recognized several forms of *J. evarete zonalis* in Cuba.

In Jamaica, *J. coenia* has never been recorded. Avinoff and Shoumatoff (1946) listed two species from Jamaica, *J. zonalis* (Felder) and *J. genoveva* (Cramer). They further recorded that *J. zonalis* was abundant in open fields but that they did not collect *J. genoveva*. Brown and Heine-man (1972) followed Munroe (1951) in regarding *zonalis* and *genoveva* as wet and dry forms of a single species *Precis evarete* Cramer (= *Junonia evarete* Cramer).

We regard Comstock's (1944) *Junonia evarete zonalis* and *J. e. genoveva* as distinct species in Jamaica. The establishment of specific names for these two species was made by reference to the original drawings of Cramer (1779, Plate 203, C & D) for *J. evarete* and Cramer (1780, Plate 290, E & F) for *J. genoveva*. The relevant parts of these plates are reproduced here as Figure 1. Although both of these species were originally described from Surinam and the original types were destroyed, the plates and the descriptions enabled us to identify the two Jamaican species. Thus we propose to discontinue using the name *zonalis* (Felder & Felder) and use *J. evarete* (Figs. 2 and 3) and *J. genoveva* (Figs. 4 and 5) for Jamaican specimens.

Cramer's (1779) drawings of *J. evarete* show no distinct eyespots on the underside of the hindwings and a greatly restricted fascia on the upper-side of the forewings. This form is similar to the uncommon species in Jamaica which was until now referred to as the *genoveva* form of *J. evarete*. Cramer's (1780) description and drawings of *J. genoveva* show specimens with well developed eyespots on the undersides of the hindwings and a wide pale fascia on the upperside of the forewings. These types resemble the common species in Jamaica hitherto known as *J. evarete zonalis*. The significance of this is that the buckeye *Junonia zonalis* or *Junonia evarete zonalis* hitherto referred to by many authors as occurring commonly in many West Indian islands, in fact should be referred to as *J. genoveva*. Conversely, the less abundant insect, formerly referred to as *J. genoveva* or *J. e. genoveva*, is in fact correctly identifiable as *J. evarete*.

The morphology and ecology of the adults and the biology of their immature stages have been studied by the senior author between 1962 and 1979, primarily from material collected at Holland Bay, Palisadoes and Green Bay in Jamaica where there are large, permanent sympatric

populations of *J. evarete* and *J. genoveva*. A total of 214 preserved specimens comprising 55 males and 38 females of *J. evarete* and 70 males and 55 females of *J. genoveva* were used for compilation of data during this study. These specimens were from the senior author's collection and from the collection at the Institute of Jamaica. Twenty-four males and 21 females of *J. coenia* from Florida, from the Rutkowski collection were also studied for comparative purposes.

Synonymy

Original identifications and Jamaican, Caymanian, Cuban and Puerto Rican descriptions only.

Junonia evarete (Cramer)

- Papilio lavinia* Cramer, 1775, Vol. 1, p. 32, pl. 21, C, D.
Papilio evarete Cramer, 1779, Vol. 3, p. 18, pl. 203, C, D.
Junonia lavinia lavinia f. *genoveva* Forbes, 1928, 305-321.
Precis lavinia f. *genoveva* Carpenter & Lewis, 1943, p. 384.
Junonia evarete genoveva Comstock, 1944, p. 455, pl. 6, fig. 13; Riley, 1975, p. 74.
Junonia genoveva Avinoff and Shoumatoff, 1946, p. 279; Wolcott, 1936, p. 399, Wolcott, 1941, p. 122.

Junonia genoveva (Cramer)

- Papilio genoveva* Cramer, 1780, Vol. 4, pl. 290, E, F.
Junonia zonalis C. & R. Felder, 1867, p. 399; Avinoff and Shoumatoff, 1946, p. 279.
Junonia genoveva (Larval description only) Swainson, 1901, p. 79.
Junonia lavinia f. *zonalis* Forbes, 1928, p. 307.
Precis zonalis Bates, 1935, p. 77; Wolcott, 1936, p. 399.
Junonia lavinia Wolcott, 1936, p. 398.
Precis lavinia f. *zonalis* Carpenter & Lewis, 1943, p. 385.
Junonia evarete zonalis Comstock, 1944, p. 454; Munroe, 1951, p. 9; Torre y Callejas, 1954; 1971, p. 24; 1974, p. 11; Riley 1975, p. 74.
Junonia evarete michaelesi Munroe, 1951, p. 10.
Junonia evarete evarete Munroe, 1951, p. 13.
Precis evarete zonalis Brown & Heineman, 1972, p. 179.
Junonia evarete Riley, 1975, p. 74.

Diagnostic Features Separating the two Species

ADULT CHARACTERS

The adults may be distinguished by reference to Table 1 and Figures 2-5. The color and extent of the sub-apical fascia on the forewings, the dis-

tribution of orange color sub-marginally on the hindwings dorsally and the ground color and maculations on the hindwings ventrally are the chief distinguishing features. There are also minor differences in wing size, some wing markings and in the coloration of the antennae.

Examination of male genitalia, testes and chromosomes provides further evidence for separation of *J. evarete* and *J. genoveva*. Carpenter and Lewis (1943) studied variation in dentition of the inner process of the terminations of the male valves in a sample of 30 *Junonia* in and around the Caribbean, including nine males from Jamaica, and noted that there was much variation in the number of spines, even on opposite valves of the same specimen.

We conducted a more detailed study of the same portion of the genitalia. We counted all the terminal spines present on both valves (at 200 x magnification) from a sample of 15 males each of *J. evarete* and *J. genoveva* and compared mean numbers of spines for each species statistically. The mean valve spine number for *J. evarete* is 17.4; (n = 15, range 12 to 21) and for *J. genoveva* the mean valve spine number is 27.6; (n = 15, range 18 to 35). *J. genoveva* has significantly more spines than *J. evarete* ($t = 7.29$, 28 d.f., $P = 0.001$). The 95% confidence limits for the difference in mean spine number between the two species is 10.2 ± 2.98 . Because there is a small overlap of spine numbers between the two species, this character will only serve to separate populations, not individuals.

The paired testes of *J. evarete* are dark brown and noticeably larger than the pink testes of *J. genoveva*. This difference was consistent in 13 specimens of *J. evarete* (26 testes) and 16 specimens of *J. genoveva* (32) testes.

Chromosome preparations of the specimens made by T. C. Emmel show that both *J. evarete* and *J. genoveva* have the same chromosome number (n = 31). However, *J. evarete* has "three notably smaller chromosomes" whilst *J. genoveva* possesses "four definitely smaller chromosomes". Emmel (pers. comm.) concludes, "on the basis of consistent karyotypes in your two sets of material sent to date. . . I would say you have two species involved rather than the one according to Brown and Heineman (1972)". The specimens featured in Figures 2-5 have all been deposited with the Allyn Museum of Entomology, Sarasota, Florida.

IMMATURE STAGE CHARACTERS

The eggs of both species are sub-globose, flattened at base and micropyle, with twelve vertical ribs which terminate around the micropyle. They are of similar size, varying between 0.65-0.68 mm in diameter at the base and between 0.58-0.61 mm in height. They can only be identified by their presence on their respective specific foodplants.

Although the larvae of *J. evarete* are always larger than those of *J. genoveva* at a similar stage of development, there is one consistent

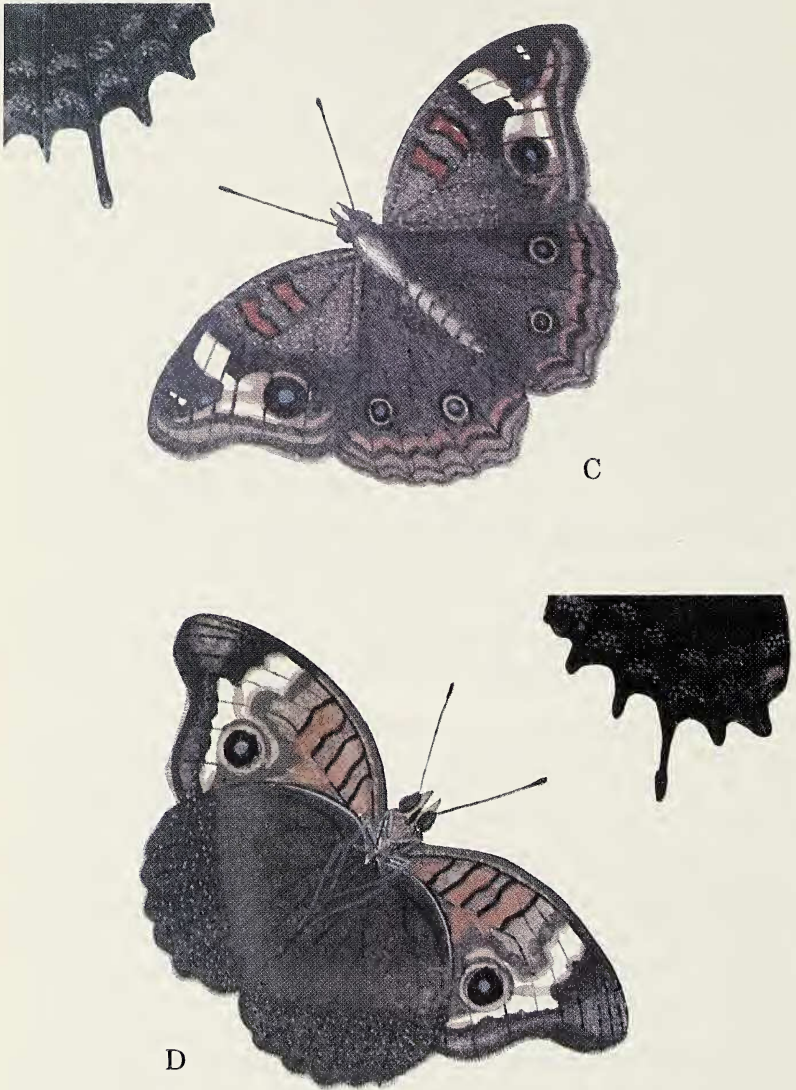
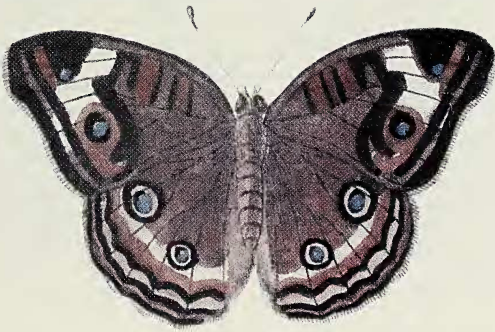


Fig. 1. Cramer's types.

Junonia evarete 1779, Plate 203. C. Dorsal, D. Ventral

Junonia genoveva 1780, Plate 290. E. Dorsal, F. Ventral

E



F



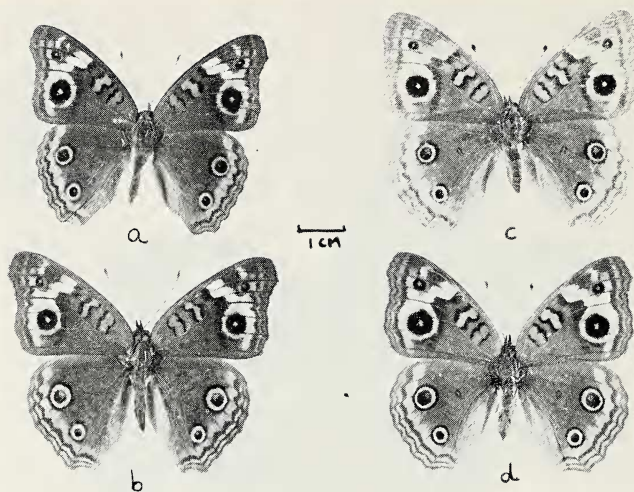


Fig. 2. Jamaican *Junonia evarete*, dorsal aspect. **a.** Male. T. Turner, Holland Bay, St. Thomas, January 14, 1968, Jamaica. W.I. **b.** Male. T. Turner, Holland Bay, St. Thomas, July 29, 1966, Jamaica W.I. **c.** female. Bred T. Turner, Holland Bay, St. Thomas, January 10, 1969, Jamaica W. I. **d.** Female. T. Turner, Holland Bay, St. Thomas, July 29, 1966, Jamaica W.I.

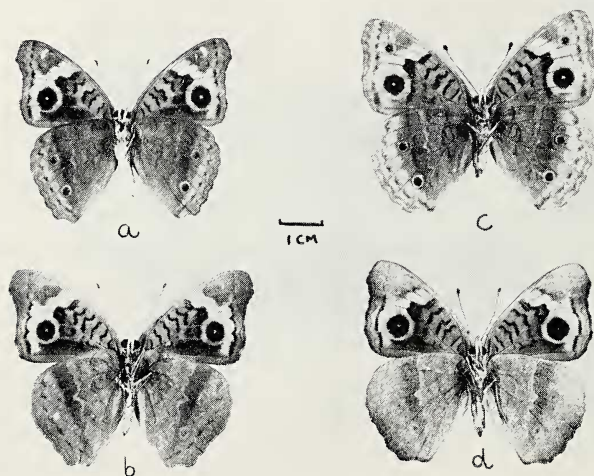


Fig. 3. Jamaican *Junonia evarete* ventral aspect. Legend as for Fig. 2.

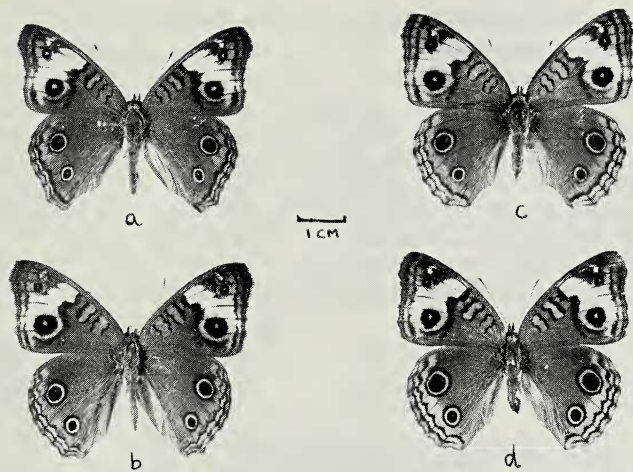


Fig. 4. Jamaican *Junonia genoveva*, dorsal aspect. a. Male. Bred T. Turner, Mona, St. Andrew, January 1, 1968, Jamaica W.I. b. Male. Bred T. Turner, Holland Bay, St. Thomas, August 7, 1966, Jamaica W.I. c. Female. T. Turner, Roselle, St. Thomas, January 14, 1968, Jamaica W. I. d. Female. T. Turner, Tower Hill, St. Andrew, July 31, 1966, Jamaica W.I.

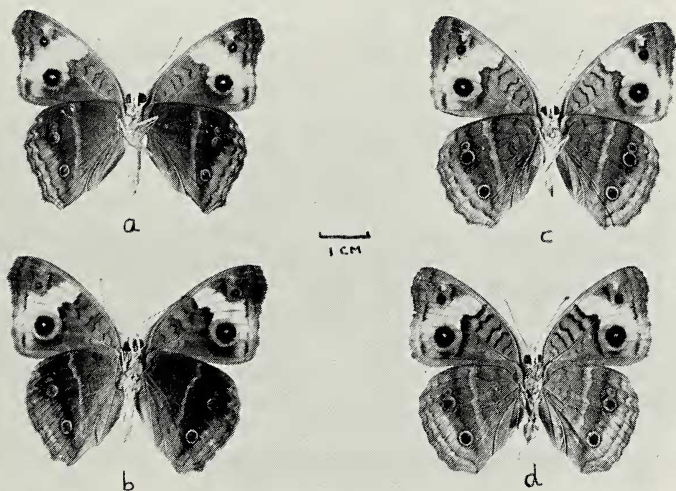


Fig. 5. Jamaican *Junonia genoveva* ventral aspect. Legend as for Fig. 4.

Table 1. Features distinguishing the adults of *Junonia evarete* from those of *Junonia genoveva* in Jamaica W.I.

EVARETE	GENOVEVA
<p>a) Fascia of forewings</p> <p>Dorsally restricted especially between veins M2 and M3; distinctly tawny. Vein M3 black and conspicuous across fascia. Ventrally the fascia does not extend to the outer wing margin.</p>	<p>Dorsally broad, white suffused with pink. Vein M3 not conspicuous across fascia. Ventrally the fascia does extend to the outer wing margin.</p>
<p>b) Orange submarginal band on the hindwings dorsally.</p> <p>Broad and conspicuous in both sexes but especially in females.</p>	<p>Reduced in the male, especially medianly; distinct or occasionally reduced in the females.</p>
<p>c) Eyespots of hindwings dorsally. Anterior eye-spot normally one-fifth to one-third larger than posterior eye-spot.</p>	<p>Anterior eye-spot one-third larger to twice as large as posterior eye-spot.</p>
<p>d) Ventral coloration of hindwings. Basically dull grey to dark brown with maculations and sub-marginal eye-spots largely obliterated by the ground color.</p>	<p>Basically brown with conspicuous maculations of variable intensity light brown to dark or reddish brown. Sub-marginal eye-spots usually distinct.</p>
<p>e) Coloration of antennae. Dark tawny or brown stem with black club.</p>	<p>Pale cream or white stem with a dark club.</p>

character which can be used to identify mature living larvae. The bases of the mid-dorsal scoli of living *J. evarete* larvae are iridescent turquoise whereas those of *J. genoveva* larvae are iridescent purple. Larvae of both species have eight rows of scoli on the thoracic segments and nine longitudinal rows of scoli on the abdominal segments, including a mid-dorsal row that is absent on the thorax.

The pupae of *J. evarete* are consistently dark brown to dark grey with black markings on the wing cases and the abdomen, whereas the pupae of *J. genoveva* are variable, being grey-brown to light brown with pink, white and greenish markings.

Ecology and Distribution of the two Species

J. evarete occurs in and around mangroves and coastal scrub in Jamaica. Seven resident populations have been located along the south

coast: Holland Bay - Rocky Point, Lyssons, Yallahs, Palisadoes - Green Bay, Old Harbour Bay, Portland Point and Starve Gut Bay. Only one population has been located on the north coast just west of Falmouth. Occasional capture of individuals between these localities at certain times indicate that some dispersal occurs.

J. genoveva is essentially an insect of open grassland islandwide, but both species fly together where mangrove woodland borders on pastureland and along roads, clearings and paths through such woodland. No specimens which could be considered hybrids between the two species were seen, even where populations of the two were sympatric. Similarly, no evidence of hybridization was observed in any of the collections studied.

The only larval foodplant of *J. evarete* in Jamaica is Black Mangrove *Avicennia germinans* (L.) (*Avicenniaceae*) (= *A. nitida* hitherto classified in the *Verbenaceae*). Most larvae have been collected feeding on cotyledons of seedlings of this plant. Larvae have been collected at Holland Bay, Palisadoes and Green Bay in April, May, November, December and January, with larvae most abundant in December. The predominantly coastal distribution of this locally occurring insect may be explained by the distribution of the larval foodplant.

The known larval foodplants of *J. genoveva* in Jamaica are *Stachytarpheta jamaicensis* (L.) Vahl., *S. cayennensis* (Rich) Vahl. (*Verbenaceae*), *Ruella tuberosa* L., and *Blechum pyramidatum* (Lam) Urb., (*Acanthaceae*). These plants are widely distributed in grassland and along roadsides throughout Jamaica, especially at elevations below 700 m. One larva was collected feeding on the ornamental *Barleria cristata* L., (*Acanthaceae*). *Asystasia* (cultivated) and *Lippia* (wild) also occurs within this species habitat but have not been noted as larval foodplants, although these are recorded as foodplants elsewhere. Larvae have been collected islandwide in all months of the year except February and April and they are most abundant between July and September.

Larvae of *J. evarete* (instars one to five) would not feed on *Stachytarpheta jamaicensis*, *Ruella tuberosa* or *Blechum pyramidatum* in captivity nor would larvae of *J. genoveva* (instars one to five) accept *Avicennia germinans* as a foodplant.

Seasonal Variation in Adult Coloration

In both species there is a tendency for specimens that emerge from pupae between December and April to be darker in ground color, both dorsally and ventrally, than those emerging between May and November. Females of *J. evarete* that emerge between May and November are conspicuously lighter in ground color on both wing surfaces. Males and females of *J. genoveva* emerging between December and April are darker in basic coloration, especially those reared from localities above 500 m.

There may also be partial obliteration of the eyespots on the ventral surface of the hindwings. At no time during the year do all of the characters (see Table 1) separating *J. evarete* and *J. genoveva* become indistinct.

The pale fascia on the forewings of *J. genoveva* is occasionally completely suffused with pink (frequency 2.4% in Jamaica, $n = 125$). Any occurrence of this coloration in *J. evarete* would be obscured by the normally tawny ground color of the fascia in this species.

Behavioral Differences between Species

Males and females of *J. genoveva* may be observed flying together close to the ground in fields or along roadsides. Flight consists of a short series of powerful wing-beats, followed by a longer series of wing-beats of small amplitude resulting in a "scudding and planing" flight. Males of *J. evarete* are common along the edges of mangroves and appear to be more strongly territorial than those of *J. genoveva*. Females of *J. evarete* remain in the mangrove woodland for the most part but appear at the woodland's edge to feed or, in late afternoon, to rest on the ground in sunlit locations. Flight in both males and females of *J. evarete* consists of a long series of powerful wing-beats as the insect rises over shrubs and trees followed by weak gliding and fluttering as the insect descends to the ground again. Males exhibit "scudding and planing" flight over short distances but for both sexes flight is predominantly "soaring and fluttering".

Discussion

Forbes (1928), Carpenter and Lewis (1943), Munroe (1951) and Brown and Heineman (1972) considered that there was a single species of *Junonia (Precis)* in Jamaica. They noted two color forms, but because of similarities in the male genitalia most authors regarded these as seasonal forms.

By collecting both "color forms" throughout the year, it became apparent that each form remained morphologically distinct despite minor seasonal variations and that these forms, for the most part, occupied separate ecological habitats. A study of the male genitalia of a sample of each color form indicated that two populations of *Junonia* were present and subsequent examination of the chromosomes confirmed that these populations represented separate species. In addition there are differences between the two species in the larval foodplants, the immature and adult stages, and in adult behavior.

No hybridization was observed where these two species occur. Using Cramer's original description of *Junonia* species from Surinam (1779 & 1780) we have applied the names *J. genoveva* to the commonly occurring

species which is distributed all over Jamaica, and *J. evarete* to the less common species which is only locally abundant.

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